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Procedia Environmental Sciences 17 (2013) 611 – 619

Procedia Environmental Sciences

The 3rd International Conference on Sustainable Future for Human Security SUSTAIN 2012

Assessing the Sustainable Development of Thailand

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Abstract

This study aims to assess the sustainable development of Thailand during 1971 – 2008 by looking at its efficiency in utilizing natural resources and environment, as measured by energy use and CO_2 emission, to create the economic growth and promote well-being of Thai people, as measured by real GDP per capita. The findings reveal that the growth of CO_2 emission and energy use was higher than that of real GDP per capita, implying that Thailand employed too much natural resources and environment in creating the economic growth and promoting well-being of its people. Moreover, we find that efficiency in utilizing natural resources and environment to create the economic growth and promote Thai people's well-being exhibited downward trend during the study period. Consequently, Thailand's development is not yet on the way to the sustained environment, natural resource, land, biodiversity and ecosystem. This situation implies that Thailand still has low opportunity to archive the sustainable development.

Selection and peer-review under responsibility of SUSTAIN conference's committee and supported by Kyoto University; (OPIR), (GCOE-ES), (GCOE-HSE), (CSEAS), (RISH), (GCOE-ARS) and (GSS) as co-hosts.

Keywords: Sustainable Development; Thailand; GDP per Capita; CO_2 Emission; Energy Use

1. Introduction

Economic growth as measured by the growth rate of gross domestic product (GDP) per capita has long been one of the key development targets of Thailand since the higher GDP per capita implies the better standard of living of Thai people, showing the economic development of the nation. To support this vision, the National Economic and Social Development Plan has been announced since 1961 with the primary objective to promote the economic growth of the nation [1]. From the first plan (1961 – 1966) to the tenth plan (2007 – 2011), Thailand is very successful in creating its economic growth, having the impressive average real GDP per capita growth rate of 4.31 percent per year during 1971 – 2008 [2]. However, such success costs Thailand several environmental problems, such as pollutions, natural

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doi:10.1016/j.proenv.2013.02.077

resource exploitation, deforestation and environmental decadence [1]. With such problems, it is impossible for Thailand to achieve the sustainable development and for Thai people to have the sustainable well-being.

The sustainable development is defined by OECD [3] as a development path along which the maximization of human well-being for today's generations does not lead to declines in future well-being. It is also defined as the development that meets the needs of the present without compromising the ability of future generations to meet their own needs [4], [5], [6]. Therefore, the sustainable development may be simply defined as the development that maximizes well-being of today's generations and maintains resources to maximize well-being of future generations. Attaining the sustainable development requires eliminating those negative externalities that are responsible for natural resource depletion and environmental degradation [3]. Based on our Common Journey of National Research Council [4], achieving the sustainable development require the sustained life support system which include environment and natural resources so that future generations are capable of utilizing them to constantly maximize their well-being. Moreover, the sustained nature, including earth, biodiversity and ecosystems, is also required.

According to the literature reviews, one of the most important measurements of the sustainable development is the Happy Planet Index (HPI) which was developed by the New Economic Foundation (NEF) [7]. The HPI is a composite index which measures the efficiency with which countries convert limited natural resources into well-being experienced by their people [7]. The fundamental concept of the HPI is based on the fact that every country is employing natural and environmental resources to promote well-being of its people. Therefore, the HPI was developed to measures the ecological efficiency of delivering human well-being [7]. In addition, the HPI measures human well-being under three dimensions, including life satisfaction, life expectancy and ecological footprints [7].

Accordingly, ecological footprints measure how much land area is required to sustain a given population at present levels of consumption, technological development and resource efficiency [7]. They are considered as the input which is utilized to promote happy life years as measured by life satisfaction and life expectancy. Therefore, the HPI will decrease as the ecological footprints increase, implying the lower human well-being and the lower opportunity to achieve the sustainable development. Additionally, the HPI has been calculated and released for three times in 2006, 2009 and 2012 [8]. The findings reveal that Thailand's HPI decreases from 55.4 in 2006 to 53.5 in 2012, implying the decreasing human well-being and, of course, the lower opportunity to achieve the sustainable development. Such decreasing HDP is caused by the increasing ecological footprints per capita from 1.6 hectors in 2006 to 2.4 hector in 2012. Although the HPI can clearly reflect the situation regarding the sustainable development of Thailand but it still has a limitation on the utilization since the HPI only provides the information for short period of times, causing a difficulty in setting the a development target for Thailand.

Besides the HPI, there are also several studies focusing on the sustainable development. For instance, Ivanovic et al. [9] and Golusin et al. [10] developed the sustainable development index for evaluating the sustainable development of 12 countries in Southern Europe by looking at several economic, social and environmental indicators. The environmental indicators include ploughed ground, irrigation, and usage of fertilizers, organic agriculture /ploughed ground, usage of pesticides, emission of methane, and emission of carbon dioxide, forestation and usage of energy. However, following the sustainable development index from Ivanovic et al. [9] and Golusin et al. [10] is hardly possible for Thailand due to the limitation of the data. Furthermore, such index hardly suggests the development target for Thailand. That is, such index cannot suggest the amount of resource use needed to reduce so that Thailand can achieve the sustainable development.

Based on the literature reviews, study on the sustainable development in Thailand is still very limited, causing the limitation on the policy formulation and implementation to promote the sustainable

development in the nation. Consequently, this study aims to assess the sustainable development of Thailand during 1971 – 2008 to shed more lights on the situation regarding its sustainable development. Weighted real GDP per capita and Data Envelopment Analysis are employed to evaluate the sustainable development of Thailand and to set the development target toward the sustainable development for Thailand. Hopefully, the results from this study will be useful to the government and the authorities in setting the development target and formulating and implementing public policies to achieve the sustainable development in the future.

2. Analytical Method

The analytical method of this study is divided into two sections. The first section aims to assess the sustainable development by considering weighted real GDP per capita where the latter section aims to assess the sustainable development by utilizing Data Envelopment Analysis.

2.1. Thailand's Sustainable Development Employing Weighted Real GDP per Capita

In this section, Thailand's real GDP per capita will be weighted by CO_2 emission and energy use in order to calculate the weighted real GDP per capita. The calculation is performed by the following steps.

Step 1: CO_2 emission index and energy use index are calculated by the following formula.

$$\text{Index}_{t,0} = [Q_t/Q_0] \times 100 \quad (1)$$

Where $\text{Index}_{t,0}$ = index value in year t, Q_t = quantity in year t and Q_0 = quantity in base year which is 1971.

Step 2: Thailand's weighted real GDP per capita is calculated under three different situations.

1. Real GDP per capita weighted by CO_2 emission ($\text{WGDP1}_{t,0}$) is calculated by the following formula.

$$\text{WGDP1}_{t,0} = [\text{GDP}_t/\text{C-Index}_{t,0}] \times 100 \quad (2)$$

2. Real GDP per capita weighted by energy use ($\text{WGDP2}_{t,0}$) is calculated by the following formula.

$$\text{WGDP 2}_{t,0} = [\text{GDP}_t/\text{ E-Index}_{t,0}] \times 100 \quad (3)$$

3. Real GDP per capita weighted by CO_2 emission and energy use ($\text{WGDP3}_{t,0}$) is calculated by the following formula.

$$\text{WGDP 3}_{t,0} = [\text{GDP}_t/(\text{C-Index}_{t,0} \times \text{E-Index}_{t,0})] \times 10{,}000 \quad (4)$$

Where $\text{C-Index}_{t,0}$ = CO_2 emission index in year t and $\text{E-Index}_{t,0}$ = energy use index in year t.

After weighted real GDP per capita in every situation is calculated, Thailand's sustainable development will be assessed and discussed.

2.2. Thailand's Sustainable Development Employing Data Envelopment Analysis

This section employs a so called "Data Envelopment Analysis (DEA)" to assess the sustainable development of Thailand during 1971 – 2008. The DEA is a non-parametric analytic technique to measure the relative efficiency of decision making units (DMUs) which operate with the same inputs and

outputs. The fundamental concept of DEA is to compare each DMU with the best DMU. The best DMU will be assigned the efficiency score of 1 or 100%. Any DMU with the less than 1 efficiency score is said to be inefficient [11]. Normally, DEA is employed to measured the efficiency of many DMUs, such as commercial banks [12], [13], insurance companies [14] and educational institutions [15], [16], in a certain period of time.

However, this study will instead utilize DEA to assess the efficiency of Thailand in utilizing inputs, as measured by CO_2 emission and energy use, to generate output, as measured by real GDP per capita, in 36 years during 1971 – 2008. Therefore, the efficiency score obtained from DEA in this case will be assign to each year instead of each DMU like the traditional DEA. The best year will thus be assigned the efficiency score of 1, implying the best practice year in this study. The production in such a year is the efficient production, implying the best utilization of inputs to produce outputs. Any year with the less than 1 efficiency score is considered inefficient, implying inefficient production in that year. High efficiency in production of course implies good opportunity to achieve the sustainable development since it means that resources are efficiently utilized to produce outputs.

Despite the existence of several DEA models, input-oriented CCR model, which is based on the assumption of constant return to scale, is employed to measure the efficiency in utilizing the minimum inputs to produce a certain amount of outputs. The DEA model to be solved is as the following.

$$\min_{\lambda} z_0 = \theta_0 \tag{5}$$

Subject to

$$\sum_{j=1}^{n} \lambda_j y_{rj} \geq y_{r0} \qquad r = 1, 2, \dots, s \tag{6}$$

$$\theta_0 x_{i0} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad i = 1, 2, \dots, m \tag{7}$$

$$\lambda_j \geq 0 \qquad j = 1, 2, \dots, n \tag{8}$$

Where θ = efficiency score, y_{rj} = amount of output r in year j, x_{ij} = amount of input i in year j and λ = non-negative weight.

In this study, there is one output which is real GDP per capita (constant 2000 US dollar) and there are two inputs, which are CO_2 emission (metric tons per capita) and energy use (kilograms of oil equivalent per capita). The linear programming model shown above will be solved to obtain the efficiency score.

3. Data and Sources

The study relies on secondary time-series data of Thailand during 1971 – 2008 obtained from World Bank (2011). The data used in this study include (1) real GDP per capita (constant 2000 US dollar), (2) CO_2 emission (metric tons per capita) and (3) energy use (kilograms of oil equivalent per capita).

4. Empirical Results

Real GDP per capita, CO_2 emission and energy use of Thailand during 1971 – 2008 are presented in Table 1. The findings reveal that these three items exhibited the upward trend during the study period. Real GDP per capita increased from 656.47 US dollar during 1971 – 1975 to 2,543.16 US dollar during 2006 – 2008. In addition, CO_2 emission and energy use also dramatically increased from 0.567 metric tons per capita and 382.10 kilograms of oil equivalent per capita during the first period to 4.189 metric tons per capita and 1,508.04 kilograms of oil equivalent per capita during the last period. As looking their

growth rates, the problem is noticeable. That is, during 1971 – 2008, the average growth rate of real GDP per capita was 4.31 percent per year whereas that of CO_2 emission was 5.71 percent per year. Moreover, we find that CO_2 emission had the higher growth rates than real GDP per capita in 6 out of 8 year periods. In terms of energy use, its average growth rate (3.96 percent per year) was only a bit lower than that of real GDP per capita. However, energy use grew faster than real GDP per capita only in 3 year period.

These findings imply the inefficiency in utilizing natural resources and environment to promote the well-being of Thai people during the study period. In other words, Thailand employed too much resource and caused too much pollution for its economic transaction. Such situation is certainly a hindrance to its sustainable development. Nevertheless, there is a good sign, showing the better situation regarding the sustainable development in Thailand. That is, during the last period, 2006 – 2008, real GDP per capita had the higher growth rate than both CO_2 emission and energy use. If this situation is persistent, the sustainable development in Thailand should be possible.

Table 1. Real GDP per Capita, CO_2 Emission and Energy Use of Thailand during 1971 – 2008

Year	Value			Growth Rate (% per Year)		
	GDP per Capita	CO_2 Emission	Energy Use	GDP per Capita	CO_2 Emission	Energy Use
1971-1975	565.47	0.567	382.10	3.05	3.20	3.17
1976-1980	722.21	0.758	455.88	5.41	7.67	2.50
1981-1985	872.17	0.844	448.36	3.36	1.92	0.40
1986-1990	1,160.52	1.254	596.23	8.07	11.82	8.82
1991-1995	1,735.97	2.468	892.43	7.39	11.89	6.90
1996-2000	1,961.17	3.237	1,130.82	-0.69	0.96	1.98
2001-2005	2,161.31	3.780	1,331.64	3.88	5.13	4.56
2006-2008	2,543.16	4.189	1,508.04	3.34	0.48	2.62
1971-2008				**4.31**	**5.71**	**3.96**

4.1. Thailand's Sustainable Development Employing Weighted Real GDP per Capita

Let us first look at real GDP per capita weighted by energy use presented in Table 2. It is the only weighted real GDP per capital which had the positive average growth rate during 1971 – 2008. Unfortunately, it increased from 533.05 US dollar during 1971 – 1975 to only 607.51 during 2006 – 2008 with the average growth rate of only 0.35 percent per year during the study period. We also find that real GDP per capita weighted by energy use had the negative growth rates during 4 out of 8 year periods. At this rate, Thailand is not likely to achieve the sustainable development since this figure is considered very low and not likely to bring Thai people the sustained well-being. The situation gets worse as looking at real GDP per capita weighted by CO_2 emission, since it exhibited downward trend during the study period. That is, real GDP per capita weighted by CO_2 emission decreased from 565.47 US dollar during 1971 – 1975 to 307.51 US dollar during 2006 – 2008 with the negative growth rates during 6 out of 8 year periods and the negative average growth rate of -1.40 percent per year. Finally, the findings reveal that real GDP per capita weighted by both CO_2 emission and energy use also exhibited downward trend during the study period. However, it sharply decreased from 477.76 US dollar during the first period to only 73.45 US dollar during the last period with the negative average growth rate of -5.36 percent per year. Moreover, its growth rates were negative during 6 out of 8 year periods.

Based on real GDP per capita weighted by only CO_2 emission and both CO_2 emission and energy, it is hard to conclude that Thai people have had the higher standard of living and well-being during 1971 – 2008 given the fact that natural resource exploitation, environmental decadence and pollution are the costs of such higher standard of living and well-being. Therefore, Thai people are unlikely to have the sustained well-being given this unsustainable development. Anyway, as looking at the growth rates of weighted real GDP per capital under all 3 situations during 2006 – 2008, there is a good sign for the sustainable development. That is, its growth rates under all situations were positive during this period, implying the improvement toward the sustainable development.

Table 2. Weighted Real GDP per Capita of Thailand during 1971 – 2008

Year	Value			Growth Rate (% per Year)		
	Weighted by CO_2 Emission	Weighted by Energy Use	Weighted by CO_2 Emission and Energy Use	Weighted by CO_2 Emission	Weighted by Energy Use	Weighted by CO_2 Emission and Energy Use
1971-1975	505.82	533.05	477.76	-0.15	-0.12	-3.32
1976-1980	482.76	570.01	381.83	-2.26	2.91	-4.76
1981-1985	524.50	702.18	422.41	1.44	2.96	1.04
1986-1990	476.17	702.53	297.00	-3.74	-0.75	-12.56
1991-1995	358.42	700.10	146.52	-4.50	0.48	-11.40
1996-2000	306.81	624.42	97.79	-1.65	-2.67	-3.63
2001-2005	289.69	584.98	78.84	-1.25	-0.68	-5.81
2006-2008	307.51	607.51	73.45	2.86	0.72	0.24
1971-2008				**-1.40**	**0.35**	**-5.36**

4.2. Thailand's Sustainable Development Employing Data Envelopment Analysis

The results from Data Envelopment Analysis (DEA) are presented in Table 3. The findings reveal that the efficiency score equals to 1.000 in 1982 and 1983, implying that Thailand is efficient in utilizing natural resources and environment to create the economic growth and promote its people's well-being only in these two years. Therefore, these two years will be considered as the best practice for Thailand. In other words, input-output combinations in these two years are considered as the optimal combination for production of Thailand. Therefore, the production in the other 36 years with the efficiency score of less than 1.000 is considered inefficient. The efficiency score presented in Table 3 indicates the amount of all inputs which is needed to be decreased given the constant amount of outputs so that the production can be consider efficient like the production in the best practice years, which are 1982 and 1983. For example, the efficiency in 2004 was the lowest with the score of 0.7482, implying that all inputs needed to be decreased by 25 percent in this year given the same amount of output so that the production in 2004 can be considered efficient. The efficiency score in the other years can be explained in the same manner as explained in case of year 2004.

Based on Table 3, Thailand's production seems to be inefficient during the study period since it employed too much input in production in almost every year in comparison to the production in best practice years, 1982 and 1983. Assuming that the input-output combinations in these two years present the highest possible production efficiency of Thailand, it is sensible to conclude that Thailand is not yet on the way to the sustainable development, because its natural resources and environment have not been

efficiently utilized in promoting the well-being of its people in 36 out of 38 years (having efficiency score of less than 1.000). Moreover, the efficiency even decreased over the study period since the efficiency score exhibited the downward trend during 1971 – 2008, implying that the natural resources and environment have been less efficiently utilized in creating the economic growth and promoting the well-being over this period.

The findings reveal that the average efficiency score during 1971 – 1980 equaled 0.8936 before it increased to 0.9526 during 1981 – 1990, showing that Thailand's production is more efficient. However, the average efficiency score decreased to 0.8654 during 1991 – 2000 and 0.7754 during 2006 – 2008, implying that the efficiency in utilizing natural resources and environment to promote Thai people's well-being constantly declined during these two year periods, in comparison to the best practice years. Moreover, the efficiency scores during 1998 – 2008 were less than 0.8, showing that the efficiency during these periods was far lower than the best practice years. As a result, Thailand is unlikely to achieve the sustainable development even though the findings from Table 1 and Table 2 suggest that the growth of CO_2 emission and energy use was lower than that of real GDP per capita during 2006 – 2008 and the growth rate of weighted real GDP per capita were positive during this period. This is because the production efficiency of Thailand during 2004 – 2008 only exhibited the upward trend but was still low.

Table 3. Efficiency Score during 1971 – 2008.

Year	Score	Year	Score	Year	Score	Year	Score
1971	0.9510	1981	0.9482	1991	0.8904	2001	0.7773
1972	0.8777	1982	1.0000	1992	0.9032	2002	0.7659
1973	0.8637	1983	1.0000	1993	0.9293	2003	0.7591
1974	0.9080	1984	0.9657	1994	0.9389	2004	0.7482
1975	0.9449	1985	0.9525	1995	0.9124	2005	0.7715
1976	0.8858	1986	0.9784	1996	0.8641	2006	0.7929
1977	0.8712	1987	0.9411	1997	0.8369	2007	0.8002
1978	0.8786	1988	0.9323	1998	0.7989	2008	0.7884
1979	0.8830	1989	0.9175	1999	0.7816		
1980	0.8720	1990	0.8905	2000	0.7982		
Mean	**0.8936**	**Mean**	**0.9526**	**Mean**	**0.8654**	**Mean**	**0.7754**

5. Discussion

The weighted real GDP per capita and the efficiency score presented above clearly indicate the failure of Thailand's sustainable development. That is, Thailand has employed too much natural resources and environment in creating the economic growth and promoting well-being of its people. That failure caused CO_2 emission and energy use to grow faster than real GDP per capita. In other words, the benefit from development is less than its cost. Such situation causes the constant improvement of standard of living of Thai people as measured by the growth of real GDP per capita, which increased from 565.47 US dollar during 1971 – 1975 to 2,543.16 US dollar during 2006 – 2008, to become an illusion because the environmental loss and the natural resource depletion increases with the higher rates, leading to the decreasing well-being of Thai people as those issues are taken into account.

Moreover, the efficiency in utilizing natural resources and environment to create the economic growth

and promote Thai people's well-being exhibited downward trend during 1971 – 2008 indicates the lower opportunity to attain the sustainable development. Although, the efficiency exhibited upward trend during 2004 – 2007, it does not really matter since the efficiency during that period was low in comparison to the best practice years for Thailand. Therefore, Thailand's development is not yet on the way to the sustained environment, natural resource, land, biodiversity and ecosystem. Such problems may cause the future generations to have less natural resources and less appropriate environment, leading to the lower well-being. This situation implies that Thailand still has low opportunity to archive the sustainable development.

Unlike the previous studies on the sustainable development, this study provides the useful insight regarding the sustainable development of Thailand which leads to the development target toward the sustainable development. That is, the output-input ratio in 1982 and 1983 is considered as the optimal output-input ratio for Thailand. Based on the average efficiency score during 2001 – 2008, Thailand is supposed to reduce its CO_2 emission and energy use by roughly 23 percent without the increase in its average real GDP per capita during the same period in order to attain such optimal ratio. By achieving this ratio, Thailand can be assured that its development process is likely to bring it the sustainable development and, of course, the sustained human well-being of its people.

6. Conclusion

Natural resource exploitation, environmental decadence and pollution hinder Thailand's sustainable development, causing a detrimental impact on the well-being of the future generations who may have live in the inappropriate earth, ecosystem and society without the appropriate natural resources and environment. As a result, the appropriate policies to maintain the natural resources and environment must be constantly carried out along with the economic and social development policies. However, Thailand needs to decrease CO_2 emission and energy use slowly and carefully in short run since it is still facing the limitations of production technology and related laws. As a result, a sharp decrease in CO_2 emission and energy use in short run requires the diminishing economic activity. This may also cause the detrimental impact on the economic growth of Thailand and the standard of living of Thai people.

Consequently, the appropriate policy to decrease CO_2 emission and energy use of Thailand in short run is to encourage people to realize the necessity of natural resource conservation and environmental protection. In long run, this study recommends the public policies to encourage business sector to employ more eco-friendly technology and to promote tertiary sector (focusing on service sector) in the nation. In addition, the environmental law and regulation must be seriously imposed and enforced. Finally, the human capital accumulation is also suggested. Human capital is defined as knowledge, skill, health and value embedded in individual which are obtained from education, training and health services [17].

The greater human capital implies that labor force of the nation is more productive and competitive, having the greater economic opportunity, the better career and the higher income. Additionally, they will have the better access to social services, leading to the lower income inequality in the nation. Once the human development is succeeding, the community and society will be strong and their citizens will realize that they are a part of the community and society, leading to the common concern regarding natural resource conservation and environmental protection. With these policies, Thailand will be more likely to attain the sustainable development and the sustained well-being of Thai people.

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